REMARKS

The Claim Objections

Clearer structures are provided as requested by the Office Action.

The Rejections Under 35 USC § 112, first paragraph

The rejections are rendered moot by the claim amendments.

Claim 21 is rewritten in Jepson format, which admits the electronic device as prior art and claims the improvement being the presence of an organic semiconducting layer formulation as claimed in claim 1 in said electronic device. Prior art electronic devices are by definition enabled.

The form of claim 22 has also been amended. This claim is directed to more specific products. Not a single allegation is made regarding these more specific products, e.g., no explanation or reasoning is provided as to why they are allegedly not enabled. All allegations concern only "all electronic devices" broadly. Thus, the Office Action has not carried its burden in establishing a lack of enablement for the products recited in claim 22.

The Rejections Under 35 USC § 103

The Office Action rejects claims 1-28 as being rendered obvious by Brown et al. (U.S. 7,095,044) in view of Minakata (U.S. 7,061,010).

It is unclear as to why this rejection was made. A section 103 rejection was made in the Office Action dated July 10, 2007, over the combination of these references (although in the reverse order), which rejection was overcome by the arguments in the Reply filed on November 13, 2007. See the Office Action dated February 8, 2008, withdrawing the rejection over the above references.

The current rejection merely reverses the order of these references, but provides no new reason as to why the claimed invention is allegedly obvious over the disclosures of these references. Moreover, no explanation is provided anywhere on the record or otherwise as to why the arguments already provided over these references may be found inadequate.

Accordingly, applicants request that for the reasons already provided on November 13, 2007, which are incorporated herein by reference and are reproduced for the Examiner's convenience at the end of this Reply, the current rejection be withdrawn or an explanation be provided in view of said arguments.

Nevertheless, applicants provide the following comments.

Brown does neither disclose nor suggest that a combination of a substituted pentacene with an organic binder can yield OFET devices with a significantly higher charge carrier mobility (three to five orders of magnitude), or that the mobility can even be higher than in an OFET device comprising the same semiconductor without binder.

The teaching of Minakata, on the other hand, even lead the skilled person away from the present invention. According to Minakata, the purpose of using substituted pentacenes was to increase the crystallinity of the semiconductor film (see column 6, lines 37-39 and 48-51, and column 7, lines 1-4). This is based on the idea to use the pentacene in its pure, crystalline state in the semiconductor layer. Likewise, Minakata suggests to control the crystal growth of the deposited pentacene for example by applying a temperature gradient, electric field or magnetic field, see column 6, lines 32-39. Consequently, according to the teaching of Minakata a dilution of the pentacene in the layer in any way (e.g. by mixing it with a binder) would be totally undesired, since this is expected by one of ordinary skill in the art to disrupt the crystalline structure of the pentacene. This would be contrary to the explicit intention for using substituted pentacene as taught by Minakata.

In contrast to Minakata, the present invention aims in the opposite direction (see page 1, line 35 to page 2, line 13 of the present application for an explanation), as it uses substituted polyacenes in combination with an organic binder. As explained in the application, when the substituted pentacene is mixed with an organic binder, it is effectively "diluted" by the binder. Diluting the organic semiconductor by mixing it with binders disrupts the molecular order in the semiconducting layer. Hence, following the teaching of Minakata the person skilled in the art would rather expect a reduction of the charge mobility. Diluting an organic semiconductor in the channel of an OFET for example is particularly problematic, as any disruption of the orbital overlap between molecules in the immediate vicinity of the gate insulator (the first few molecular layers) is expected to reduce mobility. Electrons or holes are then forced to extend their path into the bulk of the organic semiconductor, which is undesireable.

In view of the teachings of either Brown or Minakata, it was therefore totally surprising and unexpected for the skilled person that mixing a substituted pentacene with a binder can yield a transistor device with significantly increased charge carrier mobility.

Moreover, at the time of making the present invention there was no reason provided for the person skilled in the art to combine the teachings of Brown and Minakata. Instead, a combination of these references to arrive at the present invention could only be made in

hindsight.

Starting from Brown as the primary prior art reference, the aim would be to find new materials for use in semiconductor layers in combination with a binder, which could give higher charge carrier mobility. For this purpose, the person skilled in the art would not have considered Minakata, because Minakata teaches that substituted pentacenes are useful as semiconductors especially due to their higher crystallinity, which is not applicable in a semiconductor layer as taught by Brown.

Starting from Minakata as prior art (which was the situation in the previous rejection over these references), the aim would be to find ways how to further improve the charge carrier mobility of a semiconductor layer comprising a substituted pentacene. For this purpose, the person skilled in the art would not have considered Brown, because Minakata teaches that substituted pentacenes are suitable due to their higher crystallinity, whereas Brown teaches exactly the opposite, i.e., to dilute the semiconductor with an organic binder and thereby destroy its crystalline structure.

In each case, the skilled person could therefore not expect with a reasonable chance of success that mixing substituted pentacenes as disclosed in Minakata with a binder as taught by Brown would give an OFET device with significantly increased charge carrier mobility.

The formulation of claim is therefore clearly inventive over Brown and Minakata, either if considered alone or in combination with each other in any order.

Additionally, the present invention provides devices like OFETs with improved charge carrier mobility, improved stability and improved integrity of the organic semiconductor layer. This is achieved by using substituted polyacenes of formula I as semiconductor in combination with an organic binder. As shown in the examples this gives OFET devices with high charge carrier mobility (see Tables 4 and 5 on pages 52-54). Table 4 shows that the mobility in an OFET comprising a substituted polyacene with a binder (examples 12, 14) is significantly higher than in an OFET comprising the same compound without a binder (examples 13, 15). See specification and the comments provided with more detail in the Reply already provided on November 13, 2007

Brown discloses OFETs comprising an organic semiconductor and an organic binder. The examples of Brown disclose polymeric organic semiconductors like polytriarylamine, polyfluorene or polythiophene, mixed with a binder. The charge carrier mobilities achieved with these materials as reported by Brown are in the range of 10^{-4} to 10^{-5} cm^2/Vs (see the table in column 25 of Brown). In column 4, line 15, Brown further suggests using a

pentacene as organic semiconductor, however, no examples or device data are given for this compound.

Compared to the examples of Brown, the charge carrier mobility values achieved with the present invention are about three to five orders of magnitude higher (see Table 5 on page 54 with examples 12, 14, 16-21, 25 and 26). This is a significant unexpected improvement.

Minakata discloses substituted pentacenes and reports that they are suitable as semiconductors because they show a high crystallinity, see column 6, lines 37-39 and 48-51, and column 7, lines 1-4. Examples 15 and 18 of Minakata disclose OFET devices comprising a crystalline layer of a pentacene substituted with silylethynyl groups and having a charge carrier mobility of 0.08 and 0.12 cm^2/Vs.

Compared to the examples of Minakata, the charge carrier mobility values achieved with the present invention are still about one to two orders of magnitude higher (see Table 4 on pages 52 and 53 with examples 12 and 14, and Table 5 on page 54 with examples 12, 14, 16-21, 25 and 26), which is also a significant unexpected improvement.

The improvements/advantages achieved by the present invention are significant and totally surprising and could not be expected from the teaching of Brown or Minakata.

Reconsideration for the foregoing is respectfully and courteously solicited.

<u>The reasons already provided on November 13, 2007 over Minakata and Browns are reproduced below for the convenience of the Examiner:</u>

The Office Action alleges that since Minakata teaches substituted polyacenes, and Brown et al. teaches formulations comprising an organic binder, the person skilled in the art would have been motivated to combine the teachings of these references to arrive at the claimed invention.

However, there is no reason or motivation for the person skilled in the art to combine the teachings of Minakata and Brown et al. A combination of these references to arrive at the present invention could only be made in hindsight. This is especially so because Minakata teaches away from the present invention.

Minakata teaches the use of a substituted polyacene in its pure, crystalline state in a semiconductor layer. Consequently, Minakata teaches to use a substituted polyacene with better solubility, which enables the formation of semiconducting films from solution, e.g. by slow and controlled precipitation from an organic solvent, to yield films with higher crystallinity (see column 6, lines 4-39, especially lines 24-39 and column 6, line 66 - column

7, line 4 of Minakata). See, for example, column 6, lines 37-39, specifically attributing the superior characteristics of the semiconductor due to its high crystallinity.

Following the teachings of Minakata, dilution of the polyacene in an organic binder in any way would be totally undesired, since this would have been expected to disrupt the crystalline structure of the polyacene film, and hence reduce charge mobitlity, which is contrary to the original intentions of Minakata.

In contrast, the present invention teaches and claims in the opposite direction (as discussed in detail, e.g., on page 1, line 35 to page 2, line 13 of the present application), as it uses substituted polyacenes in combination with an organic binder. Slow precipitation to achieve a high degree of crystallinity is not required. Moreover, when an organic semiconducting compound is mixed with a binder, it is effectively "diluted" by the binder. However, diluting the organic semiconductor by mixing it with a binder disrupts the molecular order in the semiconducting layer. Hence, one of ordinary skill in the art would expect a reduction of the charge mobility. Diluting an organic semiconductor in the channel of an organic field effect transistor, for example, is particularly problematic, as any disruption of the orbital overlap between molecules in the immediate vicinity of the gate insulator (the first few molecular layers) is expected to reduce mobility. Electrons or holes are then forced to extend their path into the bulk of the organic semiconductor, which is undesirable.

Therefore, one of ordinary skill in the art would not expect that substituted pentacenes as disclosed by Minakata could be used together with a binder with a reasonable chance of success.

In summary, whereas Minakata teaches that substituted pentacenes are useful because they enable a highly ordered crystalline structure and close packing of the molecules, Brown et al. teaches exactly the opposite, i.e. to dilute the semiconductor and thereby destroy its crystalline structure by mixing it with an organic binder. Therefore, there is no reason or motivation for the skilled person to combine the teachings of Minakata with that of Brown et al., by mixing the substituted pentacenes of Minakata with an organic binder of Brown et al. in order to arrive at the present invention. To the contrary, Minakata teaches away from the present invention, as it teaches one of ordinary skill in the art away from modifying the polyacene film in any way which would disrupt its crystallinity.

However, instead of the expected decrease of charge carrier mobility, the formulation of the present invention even leads to a significant and unexpected advantage/improvement/ increase in the mobility and its uniformity.

Although not necessary for overcoming the rejections for reasons discussed above, and not being relied on, applicants discuss below said significant and unexpected advantage/improvement/ increase in the mobility and its uniformity over the prior art.

The formulations of the claimed invention comprise a substituted polyacene as semiconductor and an organic binder. As shown in the examples of the present application, this leads to OFET devices with high charge carrier mobility. See Tables 4 and 5 on pages 52-54, where mobilities ranging from 0.16 cm^2/Vs (example 26) to 1.4 cm^2/Vs (example 21) are achieved. In addition, Table 4 shows that the mobility in a transistor comprising a substituted polyacene with a binder (examples 12, 14) is significantly higher than in a transistor comprising the same compound without a binder (examples 13, 15). In addition, the uniformity of the mobility could be significantly improved (as illustrated by the smaller standard deviation, see discussion page 53).

The mobility values reported in the prior art references are much lower.

The examples of Brown et al. show formulations comprising polymeric semiconductors (like polytriarylamine, polyfluorene or polythiophene) and an organic binder. The charge mobilities in a transistor comprising these formulations as reported by Brown et al. are in the range from 10^{-4} to 10^{-5} cm^2/Vs (see the table on page 27 of Brown et al.). The units for the mobilities are not in the table on page 27, but it is clear based on the description as a whole that the units are in cm^2/Vs (see, e.g., page 3, line 25). Thus, the mobility values achieved by the formulations of the claimed invention herein are about three to five orders of magnitude higher.

The examples 17 and 26 of Minakata show transistor devices comprising the compound (6,13-(bis-triisopropylsilylethynyl)pentacene, which is identical to compound 1 used in examples 12, 13 and 16-20 of the claimed invention. In the devices of Minakata the compound is provided as semiconductor layer in its pure crystalline state. The mobility value of these devices as disclosed in examples 17 and 26 of Minakata is 0.12 cm^2/Vs. Thus, the mobility values achieved by the formulations of the claimed invention herein comprising the same compound (see examples 12, 13, 16-20 of the present specification) are about 100% to 350% higher.

The advantages/improvements discussed above could not have been expected from the teaching of the prior art references. Neither of these references discloses or suggests that a semiconductor layer comprising a substituted pentacene and an organic binder would show significantly higher mobility and increased uniformity compared to a semiconductor layer

comprising the pure substituted pentacene in its crystalline state. In view of the teaching of Brown et al. and Minakata as explained above, these results were totally surprising and unexpected for the skilled person.

Reconsideration is respectfully requested.

The Commissioner is hereby authorized to charge any fees associated with this response or credit any overpayment to Deposit Account No. 13-3402.

Respectfully submitted,

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